Available Thesis Topics

(January 2005)

- Electromagnetic pulse (EMP) effects on electronic systems
- Technology and concepts for position determination of distributed sensor and array elements
- Array antenna MATLAB code development
- Data processing and GUI development for the *Urbana* propagation software
- Scattering from multi-layered metamaterials
- Digital RSNS direction finding antenna
- Multi-beam digital antenna for radar, communications, and UAV tracking
- Radar glint models and multipath
- Multiple reflection approximations for physical optics codes
- Frequency, polarization, and space diversity jamming of communications in urban environments
- Radar cross section of active antennas
- Universal "zero specular reflection" design curves for multiple layers

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Frequency, polarization, and space diversity jamming of urban UAV links

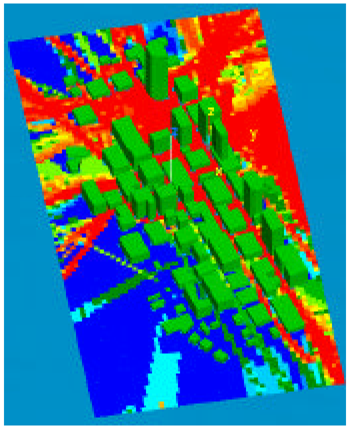
<u>Background</u>: UAV command, control and data links experience a unique propagation environment when operating in urban areas. Severe multi-path can result in a complete loss of command signals, which can limit the operational area or even cause a loss of the vehicle.

<u>Objective</u>: Examine several urban propagation environments using the code URBANA as a function of antenna polarization, frequency band, and antenna beam pattern. Determine how the propagation environment affects the command, control and communication links from the ground to the UAV.

<u>Task</u>: Become familiar with the software package URBANA and build models of the selected problems. Generate received signal contours as a function of location and frequency.

<u>Requirements</u>: Antennas and propagation

Model of urban area and computed signal contours



Digital RSNS direction finding antenna

(with Prof. Pace)

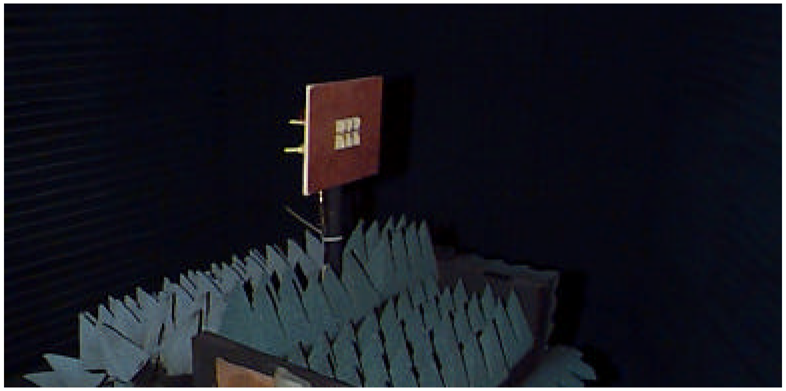
Background: Direction finders are crucial for signal interception and identification. Very wide frequency bandwidths, wide fields of view, and high resolution are desired from electrically small antennas. This is especially challenging for low frequencies.

Objective: Look at using commercially available off the shelf wireless chips for *I* and *Q* direct down conversion.

Task: Continue the study of a "digital beamformer" for the RSNS array that was started on a previous thesis. Propose a design for a demonstration antenna and examine several commercially available wireless receiver chips that might be used to construct the digital beamformer. Build a breadboard receiver and take measurements using the vector network analyzer in the Microwave Lab.

Requirements: Electronics and circuits, antenna course helpful

DF demonstration array in the NPS anechoic chamber



Multi-beam digital antenna for radar, communications, and UAV tracking based on off-the-shelf wireless technologies

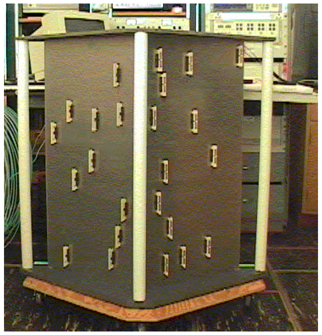
Background: Digital antennas have the potential to satisfy diverse system requirements simultaneously. The ideal digital antenna has the following features:

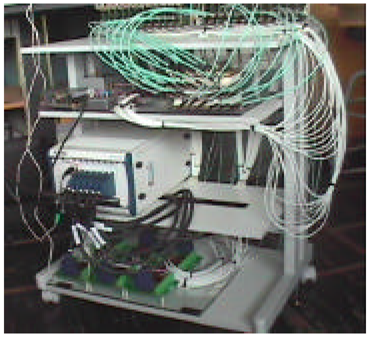
1. Potential ultra-wideband performance,
2. Use of distributed noncontiguous areas of the ship or aircraft for the antenna aperture,
3. Ability to serve several systems and perform multiple functions simultaneously (e.g., multiple beams, direction finding, search and track, and communications),
4. Low cost through the implementation of COTS,
5. Flexibility to change system parameters with simple software modifications.

Task: Several separate projects. Among them: (1) build and measure a digital receive array, and (2) simulate the antenna performance and study tradeoffs in architectures.

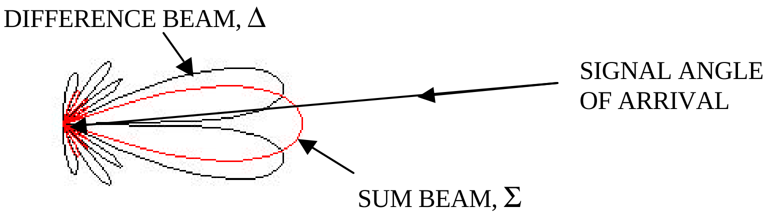
Requirements: Antenna course

Digital transmit radar antenna





UAV tracking antenna



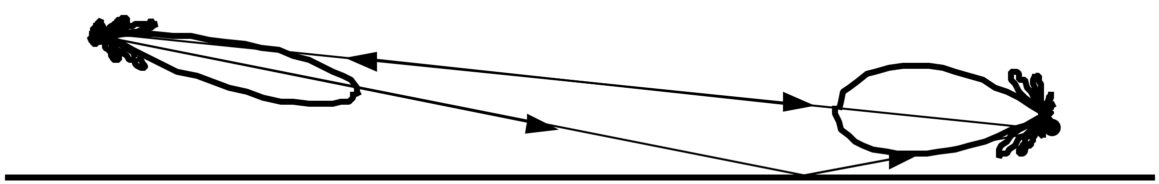
Radar glint models and multipath

<u>Background</u>: Radar targets such as aircraft have many scattering sources that interact in a complex manner. A radar tracks the “centroid” of the target; that is, a point at which the composite scattering center appears to be located. The centroid is not necessarily at the physical center of the target, and may in fact be somewhere off of the target. The result is unacceptable range and angle errors (i.e., inaccurate tracking). A similar problem occurs with the ground bounce. The radar tracks the centroid of the target return plus ground return, yielding very large tracking error.

<u>Task</u>: The objective is to study several glint models and compare the results. A complex “point scatter target” will be modeled in Matlab, and the results compared to theory. The approach will also be applied to ground bounce multipath and its effects on radar tracking examined.

<u>Requirements</u>: Antennas and radar helpful. Knowledge of Matlab recommended.

Ground bounce ECM

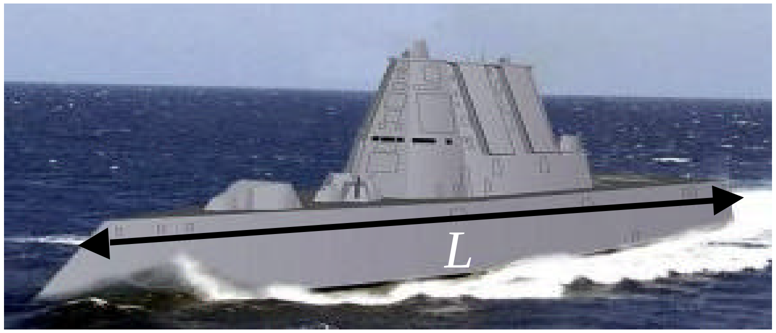


Technology and concepts for position determination of distributed sensor and array elements

Background: Recent developments in digital antenna and sensor technology make it practical to use random or irregularly spaced self-contained sensor elements that are distributed over relatively large areas. A primary example is a HF or VHF array consisting of elements placed at "locations of opportunity" over the surface of a ship. On a ship or other dynamic platform, the element positions are continuously changing, and this fact must be taken into account in the digital beamforming to avoid degradation in the sidelobes, gain, and beam pointing.

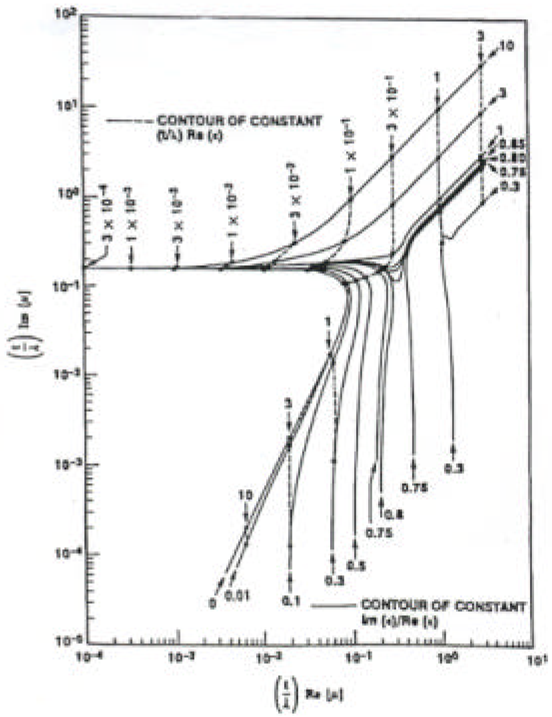
Task: This research proposes to examine a wide range of solutions to the position determination problem. They shall be evaluated based on cost, performance, complexity, and technical risk. The techniques shall be incorporated into system simulations and analyses, and an investigation into the current state of the art of applicable hardware will also be conducted. Time permitting, the purchase of off-the-shelf hardware and integration it into a subsystem to demonstrate a concept or validate performance is possible.

Array elements distributed over the entire length of the ship



Universal cuves for specular radar absorbing material (RAM) design

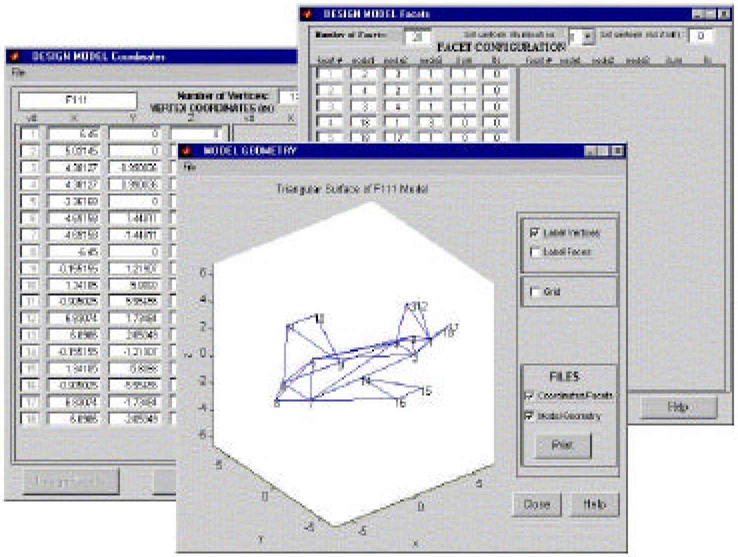
<u>Background</u>: Radar absorbing materials are used on low observable (stealth) aircraft. RAM is used to cover both conducing and composite surfaces. Design curves are used to determine the electrical properties of the materials so that no reflection occurs.
<u>Objective</u>: Generate "universal" design curves for specular radar absorbing layers on different types of materials.
<u>Task</u>: Universal curves exist for single RAM layers on conductors. Sets of curves will be generated for RAM over other types of materials such as composites and metamaterials. The work involves numerical solutions using Matlab
<u>Requirements</u>: Antenna course; RCS helpful



Example of universal design curves

Development of radar cross section prediction software and phased array antenna modeling software

Background: Previous theses have contributed to the development of radar cross section (RCS) prediction software based on the physical optics approximation, and phased array antenna modeling software (two separate software packages). The software has been distributed free of charge and is used by several contractors and universities.
Task: The objective is to add further capabilities to the software packages. For the RCS code, the highest priority is the addition new material configurations. For the array software, more element grid flexibility and sidelobe distributions are desired. The software is written in Matlab.
Requirements: Antennas helpful. Knowledge of Matlab.



POFACETS program GUI for RCS prediction